REMARKS

Claims 1-3 are herein canceled and new claims 4-21 are entered.

The amendments made above add no subject matter that is not fully contained in the priority document -- the Japanese patent application upon which this United States application is based.

Applicants respectfully request that the claims in this preliminary amendment be regarded as the original claims for purposes of determining the filing fees, in accordance with the rules. Applicants believe that this application is ready for examination.

If there are any questions regarding this preliminary amendment, the Patent & Trademark Office is invited to call the undersigned if a telephone call would be helpful in facilitating resolution of any issue which might remain.

Respectfully submitted,

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Dated: March 11, 2004

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Signature Date

MARKED-UP SUBSTITUTE SPECIFICATION FOR VAPOR HEAT INSECT KILLING APPARATUS

Inventors: Takenoshita et al.

Attorney Docket No.: HAY-101US

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Signature Date

VAPOR HEAT INSECT KILLING APPARATUS [~~FOR MEDITERRANEAN FRUIT FLY, ORANGE SMALL FRUIT FLY, QUEENSLAND FRUIT FLY AND MELON FRUIT FLY OR THE LIKE~~]

FIELD OF THE INVENTION

This invention relates to [~~a vapor heat insect killing~~] an apparatus for killing insects, and, more particularly, a vapor heat apparatus for killing insects like fruit flies [~~a so-called fruit fly or the like such as a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and a melon fruit fly or the like grown at the fruits~~].

RELATED ART

[~~As this kind of~~] Known vapor heat insect killing [~~apparatus, it has been well known in the related art to~~] methods provide an apparatus in which a fruit processing chamber for circulating [~~and flowing~~] vapor heat in a lateral direction is provided with a fruit storing unit where vapor is forcedly flowed from below in a vertical direction, the vapor heat [~~is contacted with~~] contacting the fruits [~~(raw fruits) stored~~] in the fruit storing unit to kill eggs [~~or seeds~~] of [~~the fruit fly~~] fruit flies grown at the raw fruit (for example, refer to [~~Patent Document 1(As the example of the related art, gazette of~~] Japanese Patent Publication No. Sho 61-1094 (particularly pages 1 to 2, Figs. 1 and 3 [~~is cited)~~]).

The [~~aforesaid related art is a~~] aforementioned system [~~in which the~~] includes fruit storing units having a plurality of differential pressure fans [~~are~~] installed in the fruit processing chamber, vapor (saturated vapor) generated by a common vapor supplying means [~~and~~] , a heat exchanger [~~means is circulated and flowed by a forced circulating~~] , a fan for circulating air to [~~these~~] the fruit storing units, [~~and in turn there are provided a temperature~~] a sensor for sensing a temperature in the fruit processing chamber, a [~~temperature~~] sensor for sensing a temperature at the center of a fruit and a [~~relative humidity~~] sensor for sensing the relative humidity, in which system the vapor supplying means and the heat exchanger [~~means~~] are controlled in response to the detected signal of the [~~temperature~~] sensor [~~for~~] sensing the central temperature of the fruit, and in which after the temperature is increased [~~up~~] to the predetermined central temperature of the fruit [~~, an operation at the central temperature of the fruit is~~

~~continued~~] for a predetermined time [~~,~~] the vapor heat processing is carried out to kill eggs [~~or seeds~~] of the fruit fly grown at the fruit.

In this [~~related art~~] system, the fruits harvested at each of growing districts and each of the farmers are classified in reference to [~~an~~] the amount of moisture contained in the fruit, [~~a~~] degree of [~~ripen~~] ripeness and are further classified for every several hundred kilograms of sizes at each of the pallets and mounted.

Accordingly, [~~in the case that~~] when the vapor heating process is [~~to be~~] carried out in the aforementioned system, [~~it is practically found that~~] the central temperature of the fruits is not increased [~~under~~] by a uniform [~~increasing~~] rate due to the amount of moisture, the degree of [~~ripen~~] ripeness and the size of the fruits, and [~~an increasing~~] the increase of the central temperature of the fruits in [~~a~~] certain fruit storing [~~unit~~] units is delayed as compared with [~~an increasing~~] the increase of the central temperature of [~~the~~] fruits in [~~another~~] other fruit storing [~~unit~~] units.

However, the [~~related~~] prior art [~~has no description at all about a~~] does not provide any procedure for overcoming [~~the present situation~~] this problem. Due to this fact, [~~the fruit of which temperature is increased up to a~~] the fruits which quickly reach the predetermined central temperature [~~of the fruits in the fruit-storing unit has a continued~~] experience the vapor heating process for a longer [~~hour~~] period under a high temperature region [~~for a period in which~~] than the [~~fruit in the fruit-storing unit delayed in the increasing of~~] fruits which more slowly reach the predetermined central temperature [~~of the fruits is treated with vapor heat~~], resulting in that the fruit suffers from some [~~so-called~~] thermal troubles such as [~~shrunk~~] shrinking or its lost color luster or resiliency.

SUMMARY OF THE INVENTION

This invention [~~has been invented in reference to aforesaid related~~] overcomes the aforementioned problems of the prior art [~~circumstances and it is~~] . It is an object of the present invention to provide a vapor heat [~~insect killing~~] apparatus for killing insects such as the [~~a~~] Mediterranean fruit fly, orange small fruit fly, [~~a~~] Queensland fruit fly and melon fruit fly or the like [~~in which an increasing in temperature at the~~] by more quickly heating fruit in [~~the~~] a fruit storing unit where the increase of the central

temperature of the fruits [~~is~~] has been delayed [~~in its increasing is made fast, an increasing reach~~] . In this way, the time necessary for the temperature of each of the fruits stored in each of the fruit storing means [~~up~~] to be increased to [~~a~~] the predetermined central temperature [~~of the fruits~~] is set to a substantial same value so as to prevent any thermal troubles in advance.

[~~The present inventors et al. have studied this theme earnestly and found that the higher a relative humidity under an insect killing treatment with vapor, the higher a~~] It has been discovered that when performing the insect killing treatment with vapor, a high relative humidity allows for higher thermal conductivity [~~, the~~] . Such elevated thermal conductivity may contribute to [~~an increasing~~] a quicker increase in the central temperature of the fruits [~~, the~~] . The more an increased amount of contact of the saturated vapor per unit time against the fruit, similarly, the higher the thermal conductivity for the fruit, and the thermal conductivity may contribute to an [~~increasing~~] increase in the central temperature of the fruits [~~and have invented the present invention~~].

[~~That is, the~~] The present invention is a vapor heat [~~insect killing~~] apparatus for killing fruit flies such as the [~~a~~] Mediterranean fruit fly, orange small fruit fly, [~~a~~] Queensland fruit fly and melon fruit fly or the like, wherein a plurality of fruit storing units for storing pallets having some fruits stored therein are arranged in a fruit processing chamber [~~, air~~] . Air conditioner chambers provided with a heat exchanging means and a forced [~~circulating~~] circulation means [~~are communicated for~~] communicate with every one of [~~a plurality of~~] the fruit storing units [~~, a~~] . A plurality of air circulation units are constituted for independently and forcedly [~~air~~] blowing air from below to each of the fruit storing units [~~are constituted, each~~] . Each of the air circulating units is provided with a vapor supplying means for providing saturated vapor and the like, a [~~central temperature of the fruits~~] sensing means for sensing a temperature at the center of the fruit, a [~~temperature~~] sensing means for sensing a temperature of the air, and a [~~relative humidity~~] sensing means for sensing [~~a~~] the relative humidity of the air [~~, and the~~] . The relative humidity of the saturated vapor passing in each of the fruit storing units can be controlled [~~while~~] by controlling [~~a vapor supplying~~] the amount of vapor supplied by the vapor supplying means and

[~~a~~] the heat exchanging rate of the heat exchanging means in response to the detected signal of the sensing means for sensing the central temperature of the fruits [~~sensing means for every each of the~~] in each air circulating [~~units~~] unit.

[~~Then, as one practical example the present invention,~~] By independently controlling the vapor supplying means and the heat exchanger means [~~at the time of increasing in temperature are controlled in reference~~] in each air circulating unit in response to [~~a~~] the detected signal of the fruit temperature sensing means in [~~the case that an increasing in temperature of the~~] each air circulating unit, the rate of increase in the central temperature of the fruits in [~~a certain~~] each specific fruit storing unit [~~is delayed~~] is optimized. In other words, fruits which are not quickly heated, i.e., fruits which have central temperatures which rise more slowly in response to heating as compared [~~with an increasing in temperature of the~~] to the rate of increase in the central temperature of [~~the~~] fruits in another fruit storing unit, are exposed to air having a higher relative humidity [~~of the~~] created by controlling the saturated vapor passing in [~~the~~] its fruit storing [~~units storing the fruits where the increasing in temperature of the central temperature of the fruits is delayed is increased~~] unit so as to cause the increase in the central temperature of the fruits to [~~be made fast~~] occur more quickly. Likewise, fruits which are more sensitive to heat are exposed to air having a lower relative humidity such that their rate of temperature increase is slower.

Table 1 – Proof Data

	12:30 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	27.0	59.6	28.3
(2)	26.8	59.4	28.2
(3)	26.0	59.3	28.1
(4)	27.5	59.3	28.3
(5)	26.5	59.2	28.1
ΔT			

	14:50 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	47.1	96.0	48.1
(2)	47.1	96.1	48.2
(3)	47.0	96.0	48.1
(4)	47.1	96.2	48.2
(5)	47.1	96.0	48.1
ΔT	0.1		

	13:00 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	30.8	95.1	45.8
(2)	31.0	95.0	45.9
(3)	30.3	95.0	45.8
(4)	31.9	95.0	45.7
(5)	30.1	95.1	45.6
ΔT	1.8		

	15:05 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	47.4	96.0	48.0
(2)	47.4	96.1	48.0
(3)	47.4	96.0	48.0
(4)	47.4	96.1	48.0
(5)	47.4	96.0	48.0
ΔT	0		

	13:30 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	39.2	95.3	48.2
(2)	39.4	95.1	48.1
(3)	38.8	95.4	48.2
(4)	39.9	95.2	48.2
(5)	39.1	95.4	48.1
ΔT	1.1		

	15:55 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	37.7	71.0	29.4
(2)	35.7	72.0	28.6
(3)	36.3	74.0	29.0
(4)	34.8	73.0	28.5
(5)	35.1	76.0	28.3
ΔT			

	14:00 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	44.3	95.4	48.2
(2)	44.3	95.3	48.1
(3)	44.0	95.5	48.2
(4)	44.4	95.3	48.2
(5)	44.4	95.5	48.1
ΔT	.04		

[~~The aforesaid~~] Table 1 [~~is a proof~~] displays data for an experiment in which a mango is [~~applied~~] utilized as an example of a fruit on which an insect is to be [~~insect~~] killed. [~~As~~] The experiment was performed with an apparatus as shown in Fig. 2, [~~this is a vapor~~] in which insect killing apparatus A [~~constituted such that~~] includes air chambers 21 provided with a heat exchanging means 4 and a forced circulating means 3 for each of a plurality of fruit storing units 31 [~~((1), (2), (3), (4) and (5)) are communicated~~] which are connected to each other to constitute [~~a plurality of (5)~~] five separate air circulating units 11.

In [~~this~~] Table 1, each of (1), (2), (3), (4) and (5) corresponds to the fruit storing units 31 within each of the five separate air circulation units 11. Each of 12:30, 13:00, 13:30, 14:00, 14:50, 15:05, and 15:55 denotes a measuring time [~~, respectively~~]. 15:05 denotes a time starting a natural cooling, 15:55 denotes its finishing time and 12:30 denotes a starting time for a vapor heating process, respectively. When the operation is started at 12:30, the temperature in each of the air circulating units 11 is increased while the heat exchangers 5 are being controlled during a period in which the relative humidity in each of the air circulating units 11 is gradually increased under a predetermined increasing mode (a predetermined increasing rate) in the same manner as that of the [~~related art~~] aforementioned vapor heating insect killing method.

[~~As already known in the related art, it~~] It has been known in the case of an orange small fruit fly and a melon fruit fly or the like that some [~~seeds~~] eggs and maggots grown at a fruit are [~~died~~] killed by the vapor heating process (for example, in the case of mango, such eggs and maggots are killed when the central temperature of the fruits [~~of~~] is 47.0°C, relative humidity [~~of~~] is 90 to 100%RH, and such conditions are maintained for a processing time of 15 minutes).

It is of course apparent that [~~this~~] the specific conditions of the vapor heating process is [~~made~~] different [~~in reference to the~~] for each type of a fruit.

[~~Duration time~~] A duration of about 2 hours to 3 hours [~~is taken~~] typically passes under a predetermined increasing mode from the starting of this vapor heat processing [~~,~~] during which time the central temperature of the fruits is gradually increased up to 47.0°C and the relative humidity is [~~also~~] gradually increased up to

95%RH or more, [~~and~~] after which the process is [~~kept~~] continued for 15 minutes while the relative humidity is [~~kept as it is~~] maintained.

In Table 1, 13:00, 13:30, 14:00 and 14:50 denote measuring times in which the central temperature of the fruits is gradually increased up to 47.0°C and the relative humidity is gradually increased up to 95%RH or more. [~~Then, the~~] The noted central temperature is [~~a~~] the central temperature of the fruit in each of the air circulation units 11, the noted relative humidity is [~~a~~] the relative humidity in each of the air circulation units 11, the noted inside temperature [~~within the unit is a~~] is the temperature [~~in~~] inside each of the air circulation units 11, and ΔT denotes [~~a~~] the temperature difference between the maximum central temperature of the fruits and the minimum central temperature of the fruits among each of the air circulation units 11 [~~; respectively~~].

The central temperature of the fruits in each of the fruit storing units 31 (1), (2), (3), (4) and (5) at the measuring time of 13:00 [~~in~~] (after which 30 minutes [~~elapse~~] have elapsed after starting the vapor heating operation) has a [~~certain disturbance ranging~~] variance of fruit central temperatures which range from 30.1°C to 31.9°C. [~~A~~] Thus, the temperature difference at these central temperature of the fruits is 1.8°C.

[~~Then, it has become apparent that the~~] The intermittent atomization time for vapor in regard to the fruit storing units 31(1), (2), (3) and (5) [~~showing a certain~~] shows a delay in [~~increasing~~] the increase of the central temperature of the fruits [~~is increased as for the~~] as compared to the fruits in fruit storing unit (4) [~~storing~~] which contains the fruit showing the maximum central temperature of the fruits [~~, a~~] . In response, the heat exchanging rate of the heat exchanger means 4 is increased and the relative humidity is increased until 14:00, resulting in that the central temperature of the fruits within the fruit storing units 31 (1), (2), (3) and (5) approaches the central temperature of the fruits in the fruit storing unit 31(4) and [~~then~~] the temperature difference converges to 0.4°C.

In the case of the present invention, when the temperature difference [~~in respect to the maximum~~] between the central [~~temperature~~] temperatures of the fruits becomes, for example, 0.5°C (a set value) or more, [~~it~~] the temperature difference is

acknowledged such that the air circulation unit 11 storing the fruit having [~~a~~] the lower central temperature of the fruits [~~than the set value~~] (the modified air circulation unit) shows [~~a certain delay in increasing~~] the delay in increase in temperature in regard to the air circulation unit 11 storing the fruit [~~of~~] having the maximum central temperature of the fruits [~~at the measuring time~~], resulting in that the intermittent atomization time for vapor per predetermined time (the rate of vapor supply) is increased and at the same time a temperature of the heat exchanger means 4 is increased in such a way that the temperature in the modified air circulation unit 11 [~~may not be~~] is not decreased and the relative humidity [~~may be~~] is increased [~~in~~] with respect to the air circulation unit 11 storing the fruit [~~of~~] having the maximum central temperature [~~of the fruits, and the relative humidity is increased in regard to the air circulation unit 11 storing the fruit of the maximum central temperature of the fruits~~]. For example, [~~when a~~] the temperature difference [~~against~~] between the [~~maximum~~] central [~~temperature~~] temperatures of the fruits is 0.5°C (a set value) or more at [~~the time of measuring time of~~] 13:00, [~~as an~~] until which time the intermittent atomization of vapor lasted for 15 seconds [~~for every 1~~] per minute [~~to the~~] for each fruit storing unit 31 [~~storing the lower temperature fruit than the set value in respect to the fruit storing unit 31 for storing the fruit of the maximum central temperature of the fruits,~~] . In response to the noted temperature difference, the operation in the modified air circulation unit is changed such that the vapor is intermittently atomized for 30 to 50 seconds to increase [~~a supplying~~] the amount of vapor, and [~~as a heating caloric of 5 Kw/h of~~] the rate of the heat exchanger means (heater) 4 [~~, it~~] is increased by 1 Kw/h to several Kw/h and [~~its operation is~~] such increased rates are continued during [~~a time ranging~~] the period from 13:00 to 14:00.

The [~~number of vapor atomization per the predetermined time~~] rate of vapor supply is increased in proportion to [~~a~~] the temperature difference [~~,~~] and [~~an increasing~~] the rate of the heat exchanging means 4 is increased in proportion to the temperature difference in such a way that [~~an~~] the inside temperature in the modified air circulation unit 11 [~~may not be~~] is not cooled.

The time 13:30 denotes a measuring time during the operation [~~and even at this stage,~~] at which the temperature difference [~~converges down~~] has already decreased to 1.1°C.

[~~It is assumed that~~] At this point the saturation vapor at the fruit surfaces in the fruit storing units 31(1), (2), (3) and (5) [~~is~~] has increased and [~~a~~] the thermal conductivity for [~~an~~] increased central temperature of the fruits [~~is~~] has improved.

The set value (for example, 0.5°C) of the central temperature difference of the fruits is always [~~chased~~] monitored, the vapor supplying means C4 and the heat exchanger means 4 in the corresponding fruit storing unit 31 are controlled as described above every time a value more than the set value is detected at [~~each~~] any of the measuring times as a temperature difference [~~in respect to the maximum central temperature~~] between the central temperatures of the fruits [~~,a~~] . The vapor atomization amount for the fruit storing unit 31 to be targeted and [~~a heating calorie~~] the heating rate of the heat exchanger means 4 are increased in the fruit storing unit having fruits with lower central temperatures and the operation is continued in such a way that the temperature difference converges to a value lower than the set value by 0.5°C.

When the central temperature of the fruits at each of the fruit storing units 31 converges to a value lower than the set value at each of the measuring times, the operation returns back to an increasing mode controlled by the control unit [~~, each~~] . Each of the vapor supplying means C4 and each of the heat exchanger means 4 are controlled by the control unit [~~, and~~] such that the relative humidity and the inside temperature are increased at the predetermined increasing rate.

[~~Then, the~~] The final vapor heated state is [~~kept~~] maintained for 15 minutes from the measuring time 14:50 where the central temperature of the fruits converges to 47.0 to 47.1°C under a relative humidity of about 96%RH, then the [~~state is~~] units are cooled automatically from the time 15:05 to 15:55 and the vapor heating process is completed.

A controlling operation for controlling each of the vapor supplying means C4 and the heat exchanger means 4 and increasing their temperature at a predetermined increasing rate is set through [~~an inputting at~~] programming of a memory unit of the

control unit in response to the kind of fruit [~~,~~] and the set value of the central temperature of the fruits [~~, the aforesaid~~] . The intermittent atomization time (rate of vapor supply) and the increased heating [~~calorie~~] rate of the heat exchanger means 4 and the like can be similarly changed through [~~inputting into~~] programming the memory unit of the control unit in response to the kind of fruit to be processed.

[~~In the case of Claims 1 and 2, a~~] In preferred embodiments, a vapor [~~supplying~~] amount provided by the vapor supplying means and a heat exchanging rate of the heat exchanger means are controlled in response to a detected signal of the central temperature of the fruits sensing means for every air circulating unit [~~, a~~] . The relative humidity of saturated vapor passing in each of the fruit storing units is controlled [~~, and when an increasing~~] such that when an increase of the central temperature of the fruits in [~~one fruit stored in~~] a certain fruit storing unit is delayed as compared with the other fruit stored in another fruit storing unit [~~in reference~~] due to a contained moisture amount [~~or~~] , a degree of ripen [~~and a~~] , size or [~~the like~~] other factors, the vapor supplying means and the heat exchanger means are controlled [~~in response to the sensing signal of the fruit temperature sensing means~~] to increase the relative humidity, thereby increasing the thermal conductivity [~~is increased and the increasing rate of~~] . As a result, the rate of change is increased for the central temperature of the fruits [~~is increased and then an increasing reaching time of~~] which have experienced delayed temperature increase. In this manner the fruit stored in each of the fruit storing units [~~to a~~] are treated such that they reach the predetermined central temperature [~~of the fruits can be set substantially in a concurrent time~~] at the same time.

[~~That is, the~~] The central temperature of the fruits in each of the fruit-storing units is detected and monitored individually by the fruit temperature sensing means. Then, [~~in the case that~~] when an [~~increasing~~] increase of the central temperature of the fruits [~~of a fruit~~] stored in a certain fruit storing unit is delayed [~~more than an increasing~~] compared to the increase of the central temperature of the fruits [~~of a fruit~~] stored in another fruit storing unit, the intermittent atomization amount is increased from the vapor supplying means and at the same time [~~a~~] the heat exchanging rate of the heat exchanger means is increased ([~~a heating capacity~~] the heating rate of a

heating source is increased) for the fruit storing unit exhibiting a delayed temperature increase. With such an operation [~~as above~~], a relative humidity of saturated vapor passing through the fruit-storing unit is increased to cause the thermal conductivity to be increased and [~~an increasing~~] to increase the rate of increase of the central temperature of the fruits [~~can be increased~~].

[~~In addition, a~~] A plurality of fruit storing units for storing pallets having some fruits installed therein are preferably arranged within the fruit processing chamber, and the air conditioner chambers provided with the heat exchanging means and the forced circulation means are communicated with the fruit processing chamber [~~and at~~] . At the same time, [~~a flowing~~] an air blower means for flowing air from below in each of the fruit storing units is arranged in each of the fruit storing units to enable the vapor to forcedly circulate in each of the fruit storing units and the air conditioner chambers [~~, the~~] . The fruit processing chambers are provided with a saturated vapor supplying means, a temperature sensing means [~~for sensing a temperature~~] and a [~~relative humidity~~] sensing means for sensing a relative humidity [~~, each~~] . Each of the fruit storing units is provided with a [~~central temperature of the fruits~~] sensing means for sensing a temperature of the center of the fruit, and in the case that an [~~increasing in temperature of~~] increase in the central temperature of the fruits [~~sensing means arranged at each of the fruit storing units~~] is delayed [~~more~~] as compared with an [~~increasing~~] increase in [~~temperature of~~] the central temperature of the fruits in another fruit storing unit, the air blower means for flowing air is [~~controlled in response to the sensing signal of the fruit temperature sensing means, a blowing~~] triggered to provide an increased amount of the saturated vapor [~~flowing in~~] to the fruit storing unit having the delayed [~~increasing in~~] temperature [~~of the central temperature of the fruits is increased~~] increase to cause the [~~increasing in~~] rate of increase of the central temperature of the fruits to [~~be made fast (Claim 3)~~] increase.

Table 2 – Proof Data

	15:16 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C
(1)	29.0	80	63.3	33.2
(2)	32.3	80	63.3	33.2
(3)	30.8	80	63.3	33.2
(4)	30.3	80	65.9	33.2
(5)	30.0	80	65.9	33.2
ΔT				

	17:44 Central Temp.°C	Air Volume %	Relative Humidity %RH	Inside Temp.° C
(1)	46.5	80	95.5	47.9
(2)	46.6	80	95.5	47.9
(3)	46.7	80	95.5	47.9
(4)	46.6	80	95.6	48.0
(5)	46.7	80	95.6	48.0
ΔT	0.2			

	16:14 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C
(1)	33.9	90	95.2	45.8
(2)	34.3	85	95.2	45.8
(3)	35.1	80	95.2	45.8
(4)	33.8	90	95.3	46.0
(5)	33.9	90	95.3	46.0
ΔT	1.3			

	18:05 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp.° C
(1)	47.0	80	95.5	48.0
(2)	47.0	80	95.5	48.0
(3)	47.2	80	95.5	48.0
(4)	47.2	80	95.6	48.1
(5)	47.2	80	95.6	48.1
ΔT	0.2			

	16:44 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C
(1)	40.5	85	95.3	47.7
(2)	40.5	85	95.3	47.7
(3)	41.4	80	95.3	47.7
(4)	40.4	85	95.4	48.0
(5)	40.6	85	95.4	48.0
ΔT	1.0			

	18:20 Central Temp. °C	Relative Humidity %RH	Inside Temp.°C
(1)	47.2	95.2	47.9
(2)	47.2	95.2	47.9
(3)	47.4	95.2	47.9
(4)	47.5	95.3	48.0
(5)	47.5	95.3	48.0
ΔT	0.3		

	17:14 Central Temp. °C	Air Volume %	Relative Humidity %RH	Inside Temp. °C
(1)	44.6	85	95.4	47.9
(2)	44.6	85	95.4	47.9
(3)	45.0	80	95.4	47.9
(4)	44.9	85	95.5	48.0
(5)	44.7	85	95.5	48.0
ΔT	0.4			

	19:04 Central Temp. °C	Relative Humidity %RH	Inside Temp. °C
(1)	29.1	75.2	29.7
(2)	29.7	75.2	29.7
(3)	36.1	75.2	29.7
(4)	37.3	74.0	29.5
(5)	36.8	74.0	29.5
ΔT			

[~~The aforesaid~~] Table 2 [~~is similarly a proof~~] shows data for an experiment in which a mango is [~~applied as an example to be insect killed~~] treated to kill insects and eggs. In [~~this~~] Table 2, each of (1), (2), (3), (4) and (5) corresponds to the fruit storing units stored in one common fruit processing chamber. As shown in Fig. 5, five fruit storing units 31 ((1), (2), (3), (4) and (5)) are stored in one common fruit processing chamber 1. Air conditioning chambers 21 provided with a heat exchanging means 4 and a forced circulating means 3 are communicated with the fruit processing chamber 1 so as to constitute the vapor heat insect killing apparatus A.

Each of 15:16, 16:14, 16:44, 17:14, 17:44, 18:05, 18:20, and 19:04 denotes a measuring time [~~, respectively~~]. 18:20 denotes a time starting a natural cooling, 19:04 denotes [~~its~~] the natural cooling finishing time and 15:16 denotes a starting time for a vapor heating process [~~, respectively~~]. When the operation is started at 15:16, the temperature in the fruit processing chamber 1 is increased while the heat exchangers 4 are being controlled during a period in which the relative humidity in the fruit processing chamber 1 is gradually increased under a predetermined increasing mode (a predetermined increasing rate) in the same manner as that of the related art vapor heating insect killing method.

In Table 2, 16:14, 16:44, 17:14, 17:44 and 18:05 denote measuring times in which the relative humidity is gradually increased up to 95%RH or more. [~~Then, the~~] The noted central temperature is a central temperature in each of the fruit storing units 31, the noted relative humidity is a relative humidity in the fruit processing chamber 1, the noted inside temperature [~~within the chamber~~] is a temperature in the fruit processing chamber, the noted air volume is an air volume of an air blower means (fan) 9 for flowing air (a rate against the maximum capability), and ΔT denotes a temperature difference between the maximum central temperature of the fruits and the minimum central temperature of the fruits among each of the fruit storing units 31 [~~, respectively~~].

The inside temperature in the fruit processing chamber 1 and the relative humidity are increased under the predetermined increasing mode in the same manner as that found in Table 1 while each of the vapor supplying means C4 and the heat exchanger means 4 is controlled [~~under the control of~~] by the control unit.

The central temperature of the fruits in each of the fruit storing units 31 (1), (2), (3), (4) and (5) at the measuring time of 16:14 in which one hour [~~elapses~~] has elapsed after starting the vapor heating operation has a [~~certain disturbance~~] range of temperatures ranging from 33.8°C to 35.1°C. [~~A~~] The temperature difference [~~at~~] of these central temperature of the fruits is 1.3°C.

[~~Then, it has become apparent that an~~] The air blowing [~~capability~~] rate of the [~~air flowing~~] air blower means (fan) 9 arranged at the corresponding fruit storing unit 31 in [~~the fruit storing~~] units [~~31~~] (1), (2), (4) and (5) [~~showing a~~] is increased in response to the delay in [~~increasing~~] the increase of the central temperature of the fruits as compared against the fruit storing unit 31 (3) [~~storing the~~] which holds the fruit [~~of~~] having the maximum central temperature [~~of the fruits~~] , resulting in that the central temperature of the fruits within [~~the~~] fruit storing units 31 (1), (2), (4) and (5) approaches the central temperature of the fruits in [~~the~~] fruit storing unit 31(3) within one hour [~~up to 17:14~~] and [~~then~~] the temperature difference converges to 0.4°C.

In the case of the present invention, when the temperature difference [~~in respect to the maximum central temperature~~] between the central temperatures of the fruits becomes, for example, 0.5°C (a set value) or more, [~~it~~] the temperature difference is acknowledged such that the fruit storing unit 31 [~~for storing~~] which holds the fruit of lower temperature [~~than the set value at the central temperature of the fruits has a certain delay in increasing at the measuring time in~~] shows the delay in increase in temperature with respect to the fruit storing unit 31 [~~for storing~~] which holds the fruit [~~of~~] having the maximum central temperature [~~of the fruits, a feeding amount~~] , resulting in that the rate of the air blowing means (fan) 9 [~~for flowing air~~] is controlled so as to cause [~~a~~] the heating [~~amount~~] rate of the saturated vapor at the surface to be increased [~~more~~] to a level higher than that [~~of the fruit~~] in the fruit storing unit 31 [~~storing~~] holding the fruit [~~of~~] having the maximum central temperature [~~of the fruits~~]. For example, when a central temperature difference [~~against the maximum central temperature of the fruits~~] is 0.5°C (a set value) or more at the measuring time of 16:14, [~~an air blowing capability of~~] the air blower means (fan) 9 [~~for flowing air at~~] in the fruit storing unit 31 [~~for storing~~] holding the lower temperature fruit [~~of low~~

~~temperature by more than the set value~~] is increased from that of the normal operation (80%) and then the operation is continued for one hour until 17:14.

In contrast, in the related art, a feeding amount of the air blower means (fan) 9 [~~for flowing air~~] is kept constant (80%) at the time of increasing mode described above.

The air blowing [~~capability~~] rate of the air blower means (fan) 9 [~~for flowing air~~] described above is set in proportion to the temperature difference.

In Table 2, the time 16:44 denotes a measuring time during the operation and [~~even at this stage,~~] already by this point of the operation, the temperature difference converges down to 1.0°C.

[~~It is assumed that the~~] The invention provide that the heating amount at the fruit surfaces in the fruit storing units 31(1), (2), (4) and (5) is increased and a thermal conductivity for an increased central temperature of the fruits is improved.

The set value (for example, 0.5°C) of the central temperature of the fruits is always [~~chased~~] monitored, the air blower means (fan) 9 for flowing air in the corresponding fruit storing unit 31 is controlled as described above every time a value more than the set value is detected at [~~each~~] any of the measuring times [~~as a temperature difference in respect to the maximum central temperature of the fruits~~], and the operation is continued.

In Table 2, [~~there is shown a case that an~~] the air blowing [~~capability~~] rate of the air blower means (fan) 9 for flowing air in the fruit storing units 31(1), (2), (4) and (5) is set to 85% for 30 minutes [~~ranging~~] from 17:14 to 17:44, and [~~the operation is performed and~~] the temperature difference is converged down to 0.2°C.

When the central temperature of the fruits at each of the fruit storing units 31 converges to a value lower than the set value at each of the measuring times, the operation returns back to an increasing mode controlled by the control unit [~~,~~] which controls each of the vapor supplying means C4, the heat exchanger means 4 and the air blower means 9 for flowing air [~~and the like are controlled under a control of the control unit, and~~] such that the relative humidity and the inside temperature are increased at the predetermined increasing rate.

[~~Then, the~~] The vapor heated state is [~~kept~~] maintained for 15 minutes from the measuring time 18:05 [~~where~~] when the central temperature of the fruits converges to 47.0 to 47.2°C under a relative humidity of about 95.5%RH [~~, the state is~~] . Then the fruits are cooled automatically from the time 18:20 to 19:44. The air blowing capability of the air blower means (fan) 9 for blowing air at the time of [~~keeping state~~] maintaining the vapor heated state is preferably set to 80%.

A controlling operation for controlling each of the vapor supplying means C4, the heat exchanger means 4 and the air blower means 9 [~~for flow air~~] and for increasing [~~their~~] temperature at a predetermined increasing rate is set through [~~an inputting at~~] programming a memory unit of the control unit in response to the kind of fruit being treated [~~, and the~~] . The set value of the central temperature of the fruits [~~,~~] and the increased air amount (a feeding amount) of the [~~aforesaid~~] air blower means 9 [~~for flowing air and the like~~] can be similarly changed through [~~an inputting into~~] programming the memory unit of the control unit in response to the kind of fruit to be processed.

[~~In the case of Claim 3, when~~] When the fruit stored in a certain fruit storing unit shows a [~~delayed increasing~~] slower increase of the central temperature of [~~the~~] its fruits [~~in respect to the fruit~~] compared to the fruits stored in another fruit storing unit [~~in reference~~] due to a contained moisture amount [~~or~~] , a degree of ripen [~~and a~~] or size [~~or the like~~], a [~~feeding amount per unit time~~] rate of the saturated vapor flowing in the specific fruit storing unit [~~having a delayed temperature increasing of the central temperature of the fruits~~] is increased on the basis of the sensing signal of the fruit temperature sensing means, resulting in that [~~an increasing reach time up to the predetermined central temperature of~~] the fruits [~~of the fruit~~] stored in each of the fruit storing units [~~can be performed~~] may reach the predetermined central temperature at substantially [~~in a concurrent~~] the same time.

That is, the central temperature of the fruits in each of the fruit-storing units is sensed and monitored individually by the fruit temperature sensing means. Then, in the case that [~~an increasing of~~] the central temperature of the fruits [~~of a fruit~~] stored in a certain fruit storing unit [~~is delayed more than an increasing of~~] is increasing more slowly than the central temperature of the fruits [~~of a fruit~~] stored in another fruit

storing unit, the [~~blown amount of~~] rate at which saturated vapor is blown into the low-temperature fruit-storing unit is increased by the air blower means [~~for flowing air~~] to increase [~~a~~] the heating amount [~~and then an increasing rate at~~] to increase the central temperature of the fruits [~~can be set high~~] more quickly.

The results in [~~the case of~~] Table 1 and Table 2 showed that the [~~maggot~~] maggots and [~~seeds~~] eggs of fruit [~~fly~~] flies or the like grown at a fruit were dead without producing any [~~shrunk~~] shrinking of the fruit, damaging any color luster or resiliency.

In regard to this fact, the [~~aforesaid~~] above set value is only one example, [~~and~~] but for some fruits, when [~~it~~] the predetermined temperature difference is set to 1.5°C or more, it may lead to [~~the fact that~~] the central temperature of fruits stored in another fruit storing unit [~~is~~] being rapidly increased and this is not preferable.

[~~Then~~] In such cases, the set value may be set to a value smaller than 0.5°C.

In addition, [~~when~~] the set value [~~is~~] may be sensed [~~by not only setting the measuring time shown in Table 1 and 2, but also setting the measuring time in a small stepwise~~] in a smaller incremental manner than that shown in Tables 1 and 2 or by continuously measuring it so as to sense the set value [~~,~~] and it may also be applicable to employ a control system starting a controlling operation.

[~~The present invention has been constructed as described above, so that the present invention has the following advantages.~~

~~[First aspect]~~]

When the fruits stored in a certain fruit storing unit show a [~~slow increasing~~] slower increase in [~~the~~] central temperature [~~of the fruits in respect~~] compared to the fruits stored in another fruit storing unit due to their contained moisture volume, degree of ripen and size or the like, the vapor supplying means and the heat exchanger means are controlled to cause the relative humidity to be increased and the [~~increasing~~] rate of increase in temperature to be [~~made fast~~] elevated and thus [~~it is possible to set an increasing reach time of~~] to allow each of the fruits stored in [~~the~~] each fruit storing unit [~~up to~~] to reach a predetermined central temperature [~~of the fruits~~] in a substantial concurrent manner.

[~~[Second aspect]~~]

[~~In~~] Alternatively, in the case that the fruits stored in a certain fruit-storing unit [~~show a delayed increasing of~~] have a slower increase in central temperature [~~in the fruits in respect~~] compared to the fruits stored in another fruit storing unit [~~in reference~~] due to their contained moisture content, degree of ripen and sizes or the like, the air blower means (fan) 9 [~~for blowing air arranged at the fruit storing unit is~~] may be controlled [~~,~~] such that an amount of air of the saturated vapor (a feeding amount) per unit time passing through the fruit storing unit is increased [~~,~~] and a heating amount is increased, thereby [~~an increasing reach time to the predetermined central temperature of~~] allowing each of the fruits stored in the fruit storing unit [~~can be set~~] to reach the predetermined central temperature substantially in a concurrent manner.

Due to this fact, even if the central temperatures [~~are different in their increasing~~] increase differently in response to a common environment in every fruit storing unit [~~in reference~~] due to an amount of moisture contained in the stored fruits, degree of ripen and size or the like, it is possible to prevent any thermal trouble of the fruits, keep a predetermined quality and kill the [~~seeds~~] eggs and [~~maggot~~] maggots of fruit [~~fly~~] flies grown at the fruits.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic front elevational view in section for showing a vapor heat insect killing device of a first preferred embodiment.

Fig. 2 is a schematic top plan view in cross section of a vapor heat insect killing device of a first preferred embodiment.

Fig. 3 is a schematic sectional view taken along line (3)-(3) of Fig. 1.

Fig. 4 is a schematic front elevational view in section for showing a vapor heat insect killing device of a second preferred embodiment.

Fig. 5 is a schematic top plan view in cross section of a vapor heat insect killing device of a second preferred embodiment.

Fig. 6 is a schematic top plan view in cross section for showing a vapor heat insect killing device of a third preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to Figs. 1 to 3 showing a first preferred embodiment, Figs. 4 and 5 showing a second preferred embodiment and Fig. 6 showing a third preferred embodiment, the vapor heat [~~insect killing~~] apparatus for killing insects such as a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like will be described as follows.

[~~[Preferred Embodiment 1]~~

~~Then, the first preferred embodiment will be described as follows.~~]

Figs. 1 to 3 show a preferred embodiment of the vapor heat [~~insect killing~~] apparatus for killing insects such as a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and melon fruit fly or the like [~~of the first invention,~~] wherein reference symbol A denotes a vapor heat insect killing apparatus.

[~~As this vapor heat insect killing apparatus A, these drawings~~] Figs 1 to 3 show [~~a constitution~~] an arrangement in which a plurality of rows (five rows in the preferred embodiment) of air circulating unit 11, comprised of an air conditioning chamber 21 and a fruit storing unit 31 [~~communicated~~] in communication with the air conditioning chamber, are arranged side by side within the fruit processing chamber 1 having a rectangular shape as seen in a top plan view [~~in the preferred embodiment~~] of Fig. 2.

Each of the air conditioning chambers 21 is constructed such that each of the forced circulating means (fan) 3 [~~,~~] and heat exchanging means 4 (preferably provided with a heater, a hot water coil and a cooling coil and the like) [~~is~~] are arranged inside the chamber with the forced circulating means 3 being installed at an upper side [~~, and each~~] . Each of the air conditioning chambers is [~~communicated~~] in communication with each of the adjoining fruit storing units 31 at upper side and lower side [~~, respectively~~].

Reference numeral 41 denotes a damper for controlling circulation arranged at an upper part of an interface wall 61 between each of the air conditioning chambers 21 and the fruit storing unit 31 so as to cause an upper side communicating space 51 to be released while [~~being cooperated~~] cooperating with the operation of either the forced circulating means 3 or the heat exchanger means 4.

In addition, each of the air conditioning chambers 21 is [~~communicated to~~] in communication with each other through a lower communicating space 71 opened at a lower part of the interface wall 61 for the fruit storing units 31.

Fruits B having a total [~~amount~~] mass of about 500 Kg are stored such that each of container cages 6 mounted in multi-stage states on the pallets acting as a frame 5 is separately arranged, wherein the pallets 5 are mounted on a roller conveyor D installed over an inlet 7 and an outlet 8 provided at the opposing side walls 81, 81 of the fruit processing chamber and the fruits B are loaded into the processing chamber in [~~response to each of~~] through the fruit storing units 31.

In addition, each of the frames (pallets) 5 as shown in the figure is abutted to each other between each of the fruit storing units 31 as described above, the [~~place~~] area having no frame is closed by a baffle plate 91, and a space between each of the rollers (d) in the roller conveyor D below the frame 5 [~~becomes only~~] provides an air ascending space.

Each of the air conditioning chambers 21 has a temperature sensing means (a temperature sensor) C1 and a relative humidity sensing means (a relative humidity sensor) C2 at a lower position of the heat exchanger means 4. Each of the fruit-storing units 31 is provided with [~~each of the~~] a fruit central temperature sensing means (a temperature sensor) C3 for sensing the central temperature of the fruits in the upper-most stage container cage 6.

In addition, each of the fruit-storing units 31 is provided with a humidifier acting as the vapor supplying means C4 above the upper-most stage container cage 6. The vapor supplying means C4, each of the sensing means C1, C2 and C3, the forced circulating means 3 and the heat exchanger 4 and the like [~~are communicated~~] in communication with a control unit (not shown). A vapor supplying amount and a heat-exchanging rate of the heat exchanger means are controlled by a predetermined program stored in either RAM or ROM in the control unit.

[~~Next, referring to a control flow (not shown), an operation of the vapor heat insect killing apparatus of the first preferred embodiment will be described as follows.~~]

When the apparatus is operated, the forced circulating means 3 and the heat exchanger means 4 mounted in each of the air conditioning chambers 21 are operated

together. Air is heat exchanged (heated) by the heat exchanger means 4 in each of the air conditioning chambers 21. The air is divided to flow from the lower communicating space 71 and a space between the roller conveyor D and a floor surface and ascends. The air is fed into each of the fruit storing units 31, passes through a clearance at the frames 5, and passes through the multi-stage container cages 6 [~~,~~] while its temperature is decreased by the fruits B. Upon blowing out at the upper part of the space, the air is intermittently accelerated by the vapor supplying means C4, then the air is sucked again from the upper side communicating space 51 into each of the air conditioning chambers 21. After the air is conditioned (heat exchanged) by the heat exchanger means 4, the air passes through the temperature sensing means C1 and the relative humidity sensing means C2 and again the air is fed into each of the fruit storing units 31 to form a circulating flow. [~~There occurs scarcely~~] It rarely occurs that [~~each~~] any of the divided flows is fed into [~~the~~] an adjoining fruit storing unit 31 because each of the fruit-storing units 31 is individually communicated with the forced circulating means 3 in the air conditioning chamber 21.

[~~In the case of~~] While performing the operation of the apparatus of the present invention, [~~at first~~] the increasing step 1 (an increasing mode) is first executed.

At this step 1, the vapor is intermittently atomized from the vapor supplying means (a humidifier) C4, the air containing its vapor is [~~heat exchanged~~] heated by the heat exchanger 4 at a predetermined heat exchanging rate increased in a stepwise manner so as to gradually increase a relative humidity of the saturated vapor passing in each of the fruit storing units 31 and an inside temperature and then the central temperature of the fruits in each of the fruit storing units 31 is increased substantially in a concurrent manner up to a predetermined temperature (about 47.0°C) after elapsing the predetermined time.

Subsequently, a continuing step 2 is executed. [~~This~~] In step 2 [~~sets~~] the predetermined central temperature of the fruits [~~to~~] is set and the heat exchanging rate and the vapor supplying amount (an intermittent atomization operation) are automatically selected to achieve the heating amount required for [~~being~~] continuously [~~kept~~] maintaining the predetermined central temperature [~~, monitors an inside temperature and a relative humidity in the air circulating unit 21 for every air~~

~~circulating units 11, the operation is continued~~] for a predetermined vapor heat processing time to kill the [~~seeds~~] eggs and maggot of the fruit fly grown at the fruits B. The inside temperature and relative humidity are monitored for each air circulating unit.

During [~~the aforesaid~~] step 1, the central temperature of the fruits B in each of the fruit-storing units 31 is being [~~chased~~] monitored by each of the fruit central temperature sensing means C3, and [~~in the case that an increasing of the central temperature of the~~] if an increase in the central temperature of fruits in a certain fruit storing unit 31 is delayed due to the contained moisture or degree of ripen and size or the like [~~for ever measuring points (measuring time)~~] at any point during the [~~chasing and~~] monitoring such that a temperature difference more than the set value is detected [~~in~~] with respect to the fruits [~~in the fruit storing units 31 storing the fruit of~~] having the maximum fruit central temperature, the operation is transferred to [~~the~~] step 3.

At [~~the~~] step 3, the [~~number of times~~] frequency of atomization from the vapor generating means C4 into [~~the~~] those fruit storing units 31 storing fruits having a delayed [~~increasing in the~~] central temperature [~~of the fruits~~] increase is controlled to increase the vapor supplying amount and at the same time [~~a heating calorie of~~] the rate of heating by the heat exchanger means 4 is increased [~~so as to prevent~~] such that the relative humidity is prevented from being decreased, and the central temperature of the fruits B in the fruit storing unit 31 is increased. Thus, a relative humidity of the saturated vapor passing in the fruit storing unit 31 [~~where is delayed an increasing in central temperature of the~~] storing those fruits B which have a delayed central temperature increase is made higher than a relative humidity of the saturated vapor passing in the fruit storing unit 31 storing [~~the~~] fruit [~~of the~~] having the highest or maximum central temperature [~~of fruit~~] for a predetermined period of time, [~~an increasing of~~] thus, the rate of increase of temperature for the fruit previously having the lower fruit central temperature is further [~~increased~~] elevated and the temperature difference of the fruit central [~~temperature~~] temperatures is restricted to a value lower than the set value.

This [~~control~~] operation is executed automatically every time the temperature difference of the fruit central temperature in each of the fruit storing units 31 becomes more than the set value.

When the [~~value is restricted~~] difference between the central temperatures is brought to a value lower than the set value, the operation returns back to the step 1 to cause the central temperature of the fruits B stored in each of the fruit storing units 31 to be increased up to a predetermined temperature (about 47.0°C) substantially in a concurrent manner.

[[~~Preferred Embodiment 2~~]]

Next, referring to Figs. 4 and 5, the second preferred embodiment of the second invention will be described as follows, wherein reference symbol A denotes a vapor insect killing apparatus.

This vapor heat insect killing apparatus A is different from that shown in the first preferred embodiment in which a plurality of rows of air circulating [~~unit~~] units 11, each comprised of an air conditioning chamber 21 and a fruit storing unit 31 [~~communicated~~] in communication with the air conditioning chamber, are arranged side by side, with the air conditioning chamber 21 [~~is~~] provided with [~~the~~] forced circulating means 3 and [~~the~~] heat exchanger means 4 and [~~they can be monitored for every air circulating unit 11,~~] wherein a plurality of fruit storing units 31 (five in the preferred embodiment) are stored in the fruit processing chamber 1, and the air conditioning chamber 21 including the forced circulating means (fan) 3 and the heat exchanger means 4 is communicated with the fruit processing chamber 1.

As shown in Fig. 5, the vapor insect killing apparatus A is [~~constituted~~] arranged such that both ends of the fruit processing chamber 1 [~~having~~] have a rectangular shape, as seen in [~~a~~] the top plan view of Fig. 5, and are provided with an inlet 7 and an outlet 8, a pair of roller conveyors D [~~are~~] arranged in parallel to cross the inlet 7 and the outlet 8, [~~the~~] a frame 5 [~~acting~~] serving as the pallets [~~is~~] mounted over the roller conveyors D in such a way that the frame can [~~run~~] move, and [~~the~~] two air conditioning chambers 21 which are longitudinally communicated.

As shown in Fig. 4, each of the air conditioning chambers 21 [~~is communicated~~] communicate with an upper side passage 101 and a lower side passage

111 in regard to the fruit processing chamber 1, and the forced circulating means 3, the heat exchanger means 4 (including a heater, a hot water coil and a cooling coil and the like) are arranged inside the apparatus with the forced circulating means 3 being placed [~~upside~~] above the heat exchanger means 4.

As shown in Fig. 4, the fruit-storing units 31 are constituted by the container cages 6 mounted in multi-stage on the frame 5, a hood 121 arranged to cover the container cages 6 in the upper area and enabled to be moved up and down by a winding means (not shown), and an air blower means (fan) 9 [~~for flowing air~~] arranged in the upper part of the hood 121. The fruit-storing units are stored in the fruit-processing chamber 1 while being [~~approached to each other~~] moved by the roller conveyor D as shown. A space between each of the rollers (d) in the roller conveyor D below the frame 5 becomes the only [~~an~~] air ascending space in the same manner as that of the [~~aforesaid~~] aforementioned preferred embodiment, the space ascends from a lower part toward an upper part within the container cages 6 and the air is discharged into the air processing chamber 1 [~~under a capability of~~] by the air blower means (fan) 9 [~~for flowing air from the hood 121~~].

In addition, the fruit processing chamber 1 is provided with a temperature sensing means (a temperature sensor) C1 at a forward position of the lower side passage 111 and a relative humidity sensing means (a relative humidity sensor) C2; and each of the fruit storing units 31 is provided with a [~~fruit central temperature~~] sensing means (a temperature sensor) C3 for sensing the central temperature of the fruits in the upper-most stage container cage 6.

In addition, a humidifier acting as the vapor supplying means C4 is arranged in the fruit processing chamber 1; the vapor supplying means C4, each of the sensing means C1, C2 and C3, the forced circulating means 3, the heat exchanger means 4 and the air blower means 9 [~~for flowing air and the like~~] are communicated with a control unit (not shown); and a vapor supplying amount, a heat exchanging rate of the heat exchanger means 4 and an air volume (a feeding amount) of the air blower means 9 [~~for flowing air and the like~~] are controlled by a predetermined program stored in either RAM or ROM in the control unit (not shown).

Reference numeral 41 denotes a circulating damper, reference numeral 21a denotes an air suction damper and reference numeral 131 denotes an air-discharging damper.

Next, referring to a control flow (not shown), an operation of the vapor heat insect killing apparatus of the second preferred embodiment will be described as follows.

When the apparatus is operated, the forced circulating means 3, the heat exchanger means 4 and the air blower means 9 [~~for flowing air~~] are operated together. Air passes through the clearance of the frame 5 under an air blowing function of the air blower means 9 [~~for flowing air~~], passes through the multi-stage container cages 6, [~~shows a low temperature at~~] loses heat to the fruits B, is blown [~~off at~~] out of the hood 121, thereafter the air is intermittently humidified by the vapor supplying means C4, sucked from the upperside passage 101 into the air conditioning chambers 21, 21, [~~conditioned~~] heated (heat exchanged) by the heat exchanger means 4 and then the air passes through the temperature sensing means C1 and the relative humidity sensing means C2 and is again fed into each of the fruit storing units 31 and becomes a circulating flow.

In the case of performing the operation of the apparatus of the present invention, at first the increasing step 1 (an increasing mode) is executed.

At this step 1, the vapor is intermittently atomized from the vapor supplying means (a humidifier) C4, the air containing [~~its~~] the vapor is heat exchanged by the heat exchanger 4 at a predetermined heat exchanging rate increased in a stepwise manner so as to gradually increase a relative humidity of the saturated vapor passing [~~in~~] through each of the fruit storing units 31 [~~and an~~] such that the inside temperature and then the central temperature of the fruits in each of the fruit storing units 31 is increased substantially in a concurrent manner up to a predetermined temperature (about 47.0°C) after elapsing the predetermined time.

Subsequently, a continuing step 2 is executed. [~~This~~] In step 2 [~~sets~~] the predetermined central temperature of the fruits [~~to~~] is set and the heat exchanging rate and the vapor supplying amount (an intermittent atomization operation) are automatically selected to achieve the heating amount required for [~~being~~] continuously

[~~kept~~] maintaining the predetermined central temperature [~~, monitors an inside temperature and a relative humidity in the fruit processing chamber 1, the operation is continued~~] for a predetermined vapor heat processing time to kill the [~~seeds~~] eggs and [~~maggot~~] maggots of the fruit fly grown at the fruits B. The inside temperature and relative humidity are monitored in the fruit processing chamber 1.

During [~~the aforesaid~~] step 1, the central temperature of the fruits B in each of the fruit-storing units 31 is [~~being chased~~] monitored by each of the fruit central temperature sensing means C3, and [~~in the case that an increasing of~~] when an increase in the central temperature of the fruits in a certain fruit storing unit 31 is delayed due to the contained moisture or degree of ripen and size or the like [~~for every measuring points (measuring time)~~] at any point during [~~the chasing and~~] monitoring such that a temperature difference of more than the set value is detected [~~in respect to the~~] any fruits in the fruit storing units 31 [~~storing the fruit of the maximum fruit central temperature,~~] then the operation is transferred to [~~the~~] step 3.

At [~~the~~] step 3, [~~an~~] the air volume (a feeding amount) at the air blower means 9 [~~for flowing air~~] is increased at the fruit storing unit 31 where the [~~increasing in the~~] rate of increase in fruit central temperature is slow [~~is increased and a fruit heating calorie~~] , the amount of heat supplied to the fruits therein is increased and the central temperature of the fruits in [~~the~~] that fruit storing unit 31 is increased more quickly. That is, a feeding amount of saturated vapor per unit time flowing in the fruit storing unit 31 is increased [, ~~a fruit heating calorie~~] and the heat supplied is increased [~~and a~~] such that the temperature difference of the central temperatures of the fruits is [~~restricted to the value~~] reduced to a value lower than the set value.

This control is executed automatically every time the temperature difference [~~of~~] between the fruit central [~~temperature in each of the~~] temperatures of any fruit storing units 31 becomes more than the set value.

When the [~~value~~] temperature difference is [~~restricted~~] reduced to a value lower than the set value, the operation returns back to [~~the~~] step 1 to cause the central temperature of the fruits B stored in each of the fruit storing units 31 to be increased up to a predetermined temperature (about 47.0°C) substantially in a concurrent manner.

[[~~Preferred Embodiment 3~~]]

Fig. 6 illustrates an example of modification (a third preferred embodiment) of the second preferred embodiment described above, wherein two pairs of roller conveyors D arranged in parallel to each other [~~in such a way that they may~~] such that they both cross [~~against~~] the inlet 7 and the outlet 8 of the fruit processing chamber 1 [~~, and each~~] . Each of the roller conveyors D, D is provided with a plurality of fruit storing units 31 (five in the preferred embodiment) in such a way that they can be [~~run~~] moved.

Each of the fruit-storing units 31 has [~~the~~] air blower means (fan) 9 for flowing air at the hood 121.

In [~~the~~] a preferred embodiment, the items [~~to be experimented~~] treated in Table 2 are merely [~~increased up~~] spread to ten locations and the same control is [~~the same as that of the former one~~] utilized, so [~~that its practical example is eliminated for~~] its description is not provided again.

Having described specific preferred embodiments of the invention with reference to the accompanying drawings, it will be appreciated that the present invention is not limited to those precise embodiments, and that various changes and modifications can be effected therein by one of ordinary skill in the art without departing from the scope of the invention as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A vapor heat insect killing apparatus for a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and a melon fruit fly or the like, wherein,

a plurality of fruit storing units for storing pallets having some fruits stored therein are arranged in a fruit processing chamber;

air conditioner chambers provided with a heat exchanging means and a forced circulating means are communicated for every one of a plurality of fruit storing units;

a plurality of air circulation units for independently and forcedly air blowing air from below to each of the fruit storing units are constituted;

each of the air circulating units is provided with a vapor supplying means for saturated vapor and the like, a fruit central temperature sensing means for sensing a temperature at the center of the fruits, a temperature sensing means for sensing a temperature, and a relative humidity sensing means for sensing a relative humidity;

and the relative humidity of the saturated vapor passing in each of the fruit storing units can be controlled while controlling a vapor supplying amount by the vapor supplying means and a heat exchanging rate of the heat exchanging means in response to the detected signal of the fruit central temperature sensing means for every each of the air circulating units.

2. The vapor heat insect killing apparatus for a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and a melon fruit fly or the like according to Claim 1, wherein

said vapor supplying means and the heat exchanger means are controlled in reference to a sensed signal of the fruit temperature sensing means in the case that an increasing in temperature of the fruit central temperature in a certain fruit storing unit is delayed as compared with an increasing in temperature of the fruit central temperature in another fruit storing unit, a relative humidity of the saturated vapor passing in the fruit storing units storing the fruits where the increasing in temperature of the fruit central temperature is delayed is increased so as to cause the fruit central temperature to be made fast.

3. The vapor heat insect killing apparatus for a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and a melon fruit fly or the like, wherein

a plurality of fruit storing units for storing pallets having some fruits installed therein are arranged within the fruit processing chamber;

the air conditioner chambers provided with the heat exchanging means and the forced circulation means are communicated with the fruit-processing chamber;

and at the same time an air blower means for flowing air from below in each of the fruit-storing units is arranged in each of the fruit storing units to enable the vapor to forcedly circulate in each of the fruit storing units and the air conditioner chambers;

said fruit processing chambers are provided with a saturated vapor supplying means, a temperature sensing means for sensing a temperature and a relative humidity sensing means for sensing a relative humidity;

each of the fruit-storing units is provided with a fruit central temperature sensing means for sensing a temperature of the center of the fruits;

and in the case that an increasing in temperature of the fruit central temperature sensing means arranged at each of the fruit storing units is delayed more as compared with an increasing in temperature of the fruit central temperature in another fruit storing unit, the air blower means for flowing air is controlled in response to the sensing signal of the fruit temperature sensing means, a feeding amount of the saturated vapor flowing in the fruit storing unit having the delayed increasing in temperature of the fruit central temperature is increased to cause the increasing in the fruit central temperature to be made fast.

ABSTRACT OF THE DISCLOSURE

This invention provides a vapor heat [~~insect killing~~] apparatus for treating fruits by killing insects such as, for example, a Mediterranean fruit fly, an orange small fruit fly, a Queensland fruit fly and a melon fruit fly or the like [~~, so as to prevent some~~] . The invention prevents thermal troubles experienced by fruits undergoing treatment by [~~substantially setting in a concurrent manner an increasing reach time of~~] allowing each of the fruits stored in each of the fruit storing means to reach a predetermined fruit central temperature at substantially the same time. The vapor supplying means and the heat exchanger means are controlled in reference to a sensed signal of the fruit temperature sensing means [~~in the case that an increasing in temperature of~~] . When the increase in the fruit central temperature in a certain fruit storing unit is delayed as compared with [~~an increasing in temperature~~] the increase of the central temperature of the fruits in another fruit storing unit, [~~a~~] the relative humidity of the saturated vapor passing in the former fruit storing units [~~storing the fruits where the increasing in temperature of the central temperature of the fruits is delayed~~] is increased [~~, a~~] increasing thermal conductivity [~~is increased~~] or a feeding amount of the saturated vapor passing in the former fruit storing unit is increased [~~, a heating calorie of~~] increasing the amount of heat provided to the fruit [~~is increased,~~] and increasing the thermal conductivity is [~~increased and increasing in~~] to hasten the rise in the fruit central temperature [~~is made fast~~].